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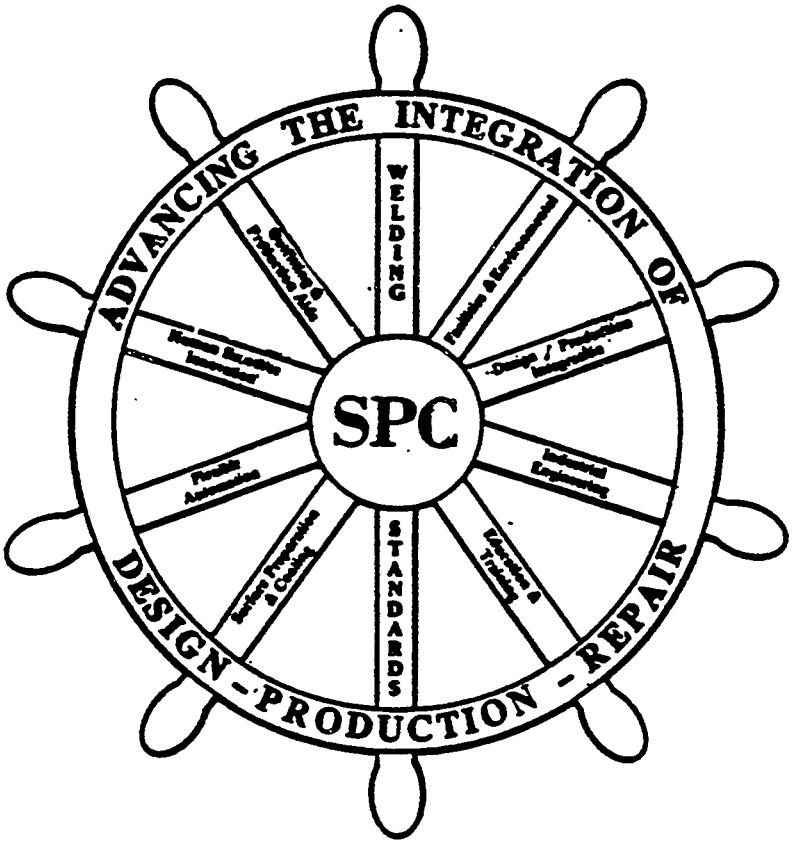

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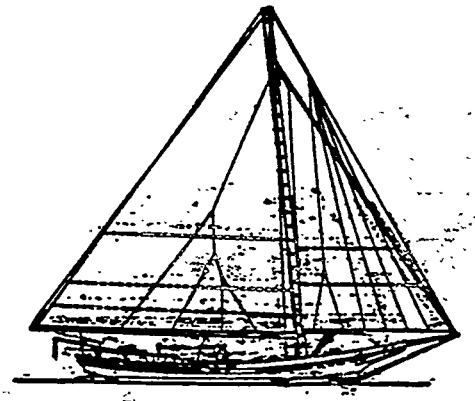

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No. 7

The Evolution of Generating of Methods and Standards in U.S. Naval Shipyards

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ABSTRRCT

The Production Industrial Engineering Resource System (PIERS) is an automated system to improve industrial engineering. One of its components is Computer Aided Time Standards (CATS), a computer-ass'.sted method to find, manipulate and store standard time data and existing standards to create new standards (1). CATS provides immediate, user-friendly access to the over 18,000 elements of standard time data and standards published by all shipyards. The system evolved from the DoD Computer Aided Time Standards program to collect, validate and publish standard time data in a single source for use by all DoD work measurement organizations. CATS uses menus, prompts, and instructions displayed on the screen to first direct the user to appropriate standard time data or standards and then to lead the user through the process of constructing a new standard. Because CATS performs the required mathematical computations, many hours of tedious manual labor have been replaced with a few keystrokes. One of the keys to CATS' flexibility and usefulness is its modular design. The system now includes many time-saving software packages, and additional packages can be made part of the system quickly and inexpensively. CATS has demonstrated a cost savings and positive return on investment of 3.5:1 (2). With strong management support, the use of computer systems similar to PIERS can significantly improve the bottom lines of other organizations.

INTRODUCTION

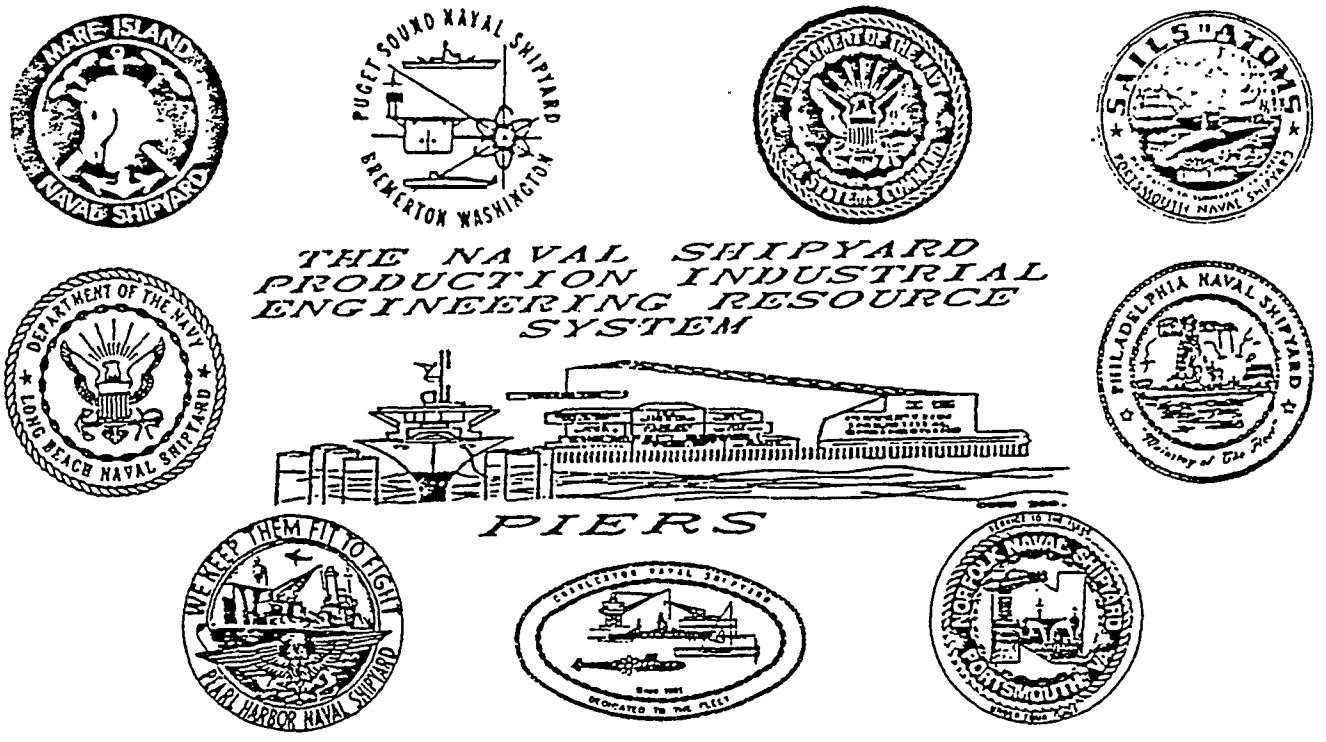
To understand what a revolutionary resource the PIERS system is, it is necessary to describe the work measurement system that predated PIERS and formed the original foundation for its data base.

This system, the Defense work Measurement Standard Time Data Program (DWMSTDP), collects work measuramemt data into a single source, which is published in nine volumes called "Standardization of Work Measurement" (DoD 5010.15.l-11) and in a DoD data base (3).

One of the most effective ways to improve the bottom line is to standardize work procedures -- to break them down into elements and make sure that each element is being used consistently in the same way in the same amount of time. The "Standardization of Work Measurement" contains descriptions and times for 18,000 of the elements that can be combined to form procedures.

These 18,000 entries were developed by Defense activities. DoD screens all entries and verifies that the methods described and the associated times are accurate before adding each of them to the DWHSTDP data baae. The DUHSTDP systematically collects, verifies and disseminates standard time data. Since the nine volumes were published 12 years ago, all the military services and many DoD agencies and commercial organizations have used the data in their work measurement programs.

Within two years after the naval shipyards began using the systems they moved away from the DWMSTDP data base (3) and began creating a data base of standard data elements (4) more suitable to their specialized needs. Navy analysts who use this data to build standards follow a three-step procedure. First, they break down.the work to be measured into elements. They establish the starting and stopping points of each element and verify exactly what work gets done during that element. Second, they search through standard data to find elements that match the elements they are measuring. Third, they add up the elements, apply frequencies, and tabulate times. An analyst can build an accurate standard without using time-consuming work measurement techniques because the stop watches have already been held -- they don't need to be held again. Only when some elements of the job cannot be matched with standard data elements *is* it necessary to use tradi-



tional work measurement techniques.

Using standard work measurement data (4) can drastically cut the time needed to create an engineered method and standard. By using standard data, engineers and technicians avoid having to "reinvent the wheel" for each new document. Each time someone does a time study, his or her work can become standard data that someone else can use. And, of *courses* the more data that becomes standardized, the less data that needs to be "assembled by hand." As the data base continues to grow, accurate standards can be created faster and faster.

To take full advantage of this ever-increasing data bases however, it was necessary to be able to access all the new standard data elements that were constantly being added to it. The more data there was to use, the more unwieldy the data base became to use. Storing, searching for, and retrieving data became increasingly costly and time-consuming. Often, because of poor record-keeping? standard data was available that the engineer or technician couldn't locate or wasn't aware existed. There is no advantage to having what You can't use. As a result, most of the standards created by naval shipyards were still being created the expensive way - slowly, from scratch, often with out the proper methods analysis.

HISTORY

Clearly, a more efficient and economical way to handle standard time data was needed. If industrial engineers and technicians no longer had to manually search for, apply and maintain standard time data, they would have more time to devote to methods analysis and improvement and cost reduction. In the late 1970"s, a DoD study concluded that using a computer system that would help generate time standards as well as store standard data elements was the best approach to this problem.

From 1980 through 1986, the Defense Productivity Programs Office (DPPO) developed and used a sophisticated program of computer technology known as CATS, or Computer Aided Time Standards. In 1987 CATS evolved into PIERS, the Production Industrial Engineering Resource System. This system is still evolving and expanding.

PIERS goes far beyond more efficient storage and retrieval of standard data. It can search for and retrieve standard data and then combine the elements it finds automatically to create a formatted method and standard. The program takes adverse *environmental* and working conditions and personal fatigue and delay into account. After creating the standard, the system can aid in analyzing the entire work process to spot tasks that can be redefined or *reorganized* to *improve* efficiency. This makes it much easier for engineers and technicians to create method improvements.

The best way to understand the full capabilities of the expanded PIERS system is to review the way it grew and

developed to meet expanding shipyard needs (2).

In 1981, the Defense Productivity Program Office introduced all the naval shipyards to CATS (4). The Philadelphia Naval Shipyard volunteered to be the prototype shipyard for the new system. *ln* 1982, Philadelphia acquired its first personal computer.

In 1983, Philadelphia technicians converted an expensive mainframe system into a stand-alone CATS system, which dramatically reduced on-line time and expense (5). One Philadelphia technician developed a program for calculating personal, fatigue and delay allowances. The program was distributed to all U.S. naval shipyards. Philadelphia industrial engineering technicians created the first methods and standards using the CATS system. Their *use* of standard time data eliminated many time-consuming field studies. The volume of throughput increaaed so much that Philadelphia purchased a second personal computer.

Software advances marked 1983, but hardware improvements accounted for most of the changes in CATS in 1984. A change in personal computer manufacturers brought more memory, speed and storage capacity to the system. Although it had been clear that the CATS concept was sound, until this hardware change the system had been somewhat difficult and time-consuming to use. Philadelphia technicians assisted in the development of a new worksheet entry program to take fuller advantage of the new equipment. The other 1984 software change was an electronic mail service between the eight naval shipyards and other DoD activities. This system has had wide acceptance and use since it was first activated.

In 1985, it was clear that CATS was about to *outgrow* its hardware once again, and the decision was made to convert to an IBM-compatible system. The software method of analysis being used was changed from the traditional production-line, stopwatch approach to a more shipyard-compatible, job-shop approach. Several software resources were added as well: an electronic bulletin board to use to exchange technical data, a data base directory to speed *information* searches, an index of standard time data, and an industrial process instruction data base.

In 1986, the planned-for Zenith personal computers arrived and are currently used for the PIERS system at the eight naval shipyards. They are almost completely IBM-compatible and are three times more powerful than the aysten they replaced. They have twice the storage capacity and eight times the speed. The Zeniths are also more user friendly and have high-resolution color graphic capabilities and faster modems, which allow faster transfers of data.

During this year, the CATS software was upgraded to CATS-E-X-P (Expanded Productivity). User suggestions about CATS were the basis for the improved CATS-E-X-P, so developing and exchanging engineered time standards was finally fast, flexible and simple. The system's IBM compatibility allowed the shipyards to add desktop publishing, computer-aided design (CAD), and data base management to their software library.

Even though improvements to the system had been steady and significant, the shipyards recognized that the engineering documentation capabilities of CATS were no *longer* enough. The next step was a complete computerized engineering toolbox. So in 1987, CATS became PIERS. Some of the needs the shipyards hoped to address with this expanded system were ways to support industrial engineering studies, speed the production of industrial process instructions, improve work scheduling and control, and make the most efficient use of the shipyards* limited people resources.

An extensive search was conducted to find applicable software and turnkey systems to include in PIERS. Dozens of computer software packages and industrial engineering systems were evaluated, benchmarked and tested in actual shipyard trials. Because PIERS is a collection of computer programs, a program called Microsoft Windows was chosen to provide an operating environment to connect all the available PIERS applications. Microsoft Windows allows users to switch from one program to a second program quickly without having to formally exit the first program. Users can also access more than one program at the same time with Microsoft Windows. In addition, this program allows data to be transferred from one program to another. The other PIERS cornerstone is Microsoft Excel, which enables users to create state-of-the-art spreadsheets and graphs.

Last year, two hardware items and three software programs were the main forces behind PIERS progress. Philadelphia began working heavily with an optical character reader, or OCR, a machine that "reads" documents and adds them to the database directly without typing (6). Another hardware item, the Costimator, enables users to totally plan machining operations.

In 1988, the shipyards acquired a specialized expert computer system for welding, developed by the American Welding Institute. This software was provided to Philadelphia welding

engineers on a cooperative basis with Philadelphia industrial engineering technicians.

1988 also saw more widespread use of PC-based, computer-aided design, or CAD. In Philadelphia, this software program is used by industrial engineering technicians to illustrate industrial process instructions and engineered methods and standards and by waterfront engineering technicians to plot ship docking services. This speeds up drawing production and eliminates the need for redrawing if the ship revisits or if similar ships dock there in the future. A third important software system, Engineering Document/Drawing Information Exchange (EDDIE), was developed and brought on line. EDDIE was a big boost to the computer communication between shipyards. The 'yards can now send and receive any industrial-engineering-related document or drawing, even those done on different machines or using different software.

Shipyards recognize that, to make maximum use of PIERS, it must be a fully integrated system, not just a loosely knit collection of parts. In 1989, shipyards are working to make PIERS a truly automated, highly functional engineering tool. PIERS will evolve into an expert system known as the PIERS Advisor.

The Advisor will make PIERS even more user-friendly and more useful. It will provide a guide to using the system and will show users what is available. The Advisor will supply users with applied industrial engineering theory as well as helpful tips. It will show users how to work with PIERS to develop industrial engineering studies.

STANDARD DATA AND STANDARD DEVELOPMENT

While PIERS is a diverse collection of automated engineering applications, the most traditional application in the system is in standard data (7) and standard development. PIERS is an excellent tool for industrial engineers and technicians who want to improve the bottom line by standardizing procedures. By standardizing your procedures you can control costs, manpower requirements and scheduling more effectively. You can track your work and forecast your future requirements. This is only the beginning. Once you standardize, you can improve your methods easily--by changing your manufacturing procedures, your layout or your machinery area. Each of these changes can result in a change to the standard that usually means a positive change in the bottom line.

PIERS can establish baselines for method improvement studies, make labor cost comparisons, compare investment alternatives, aid in conducting "what if" studies, and monitor auditing and performance. The system has sophisticated information retrieval capabilities. It will allow users to apply standards in a timely and uniform way.

PIERS contains a tailor-made tool for standardizing procedures called CATS E-X-P. This system can accommodate and integrate multiple data bases. It can easily handle standard data, standards, text (word processing), work orders, and method descriptions. It can make calculations to construct standards, do statistical analyses, and produce reports. CATS is a complete system to develop, maintain, share and apply standards. CATS E-X-P has demonstrated a cost savings and positive return-on-investment of 3.5:1 (2). In Philadelphia, for example, approximately 180 electronic/electrical standard data elements were produced by only one technician. Each of those standard elements has become a new piece of standard data. This technician is still developing new elements; 99 percent of one standard was created from standard data (8).

One of PIERS greatest strengths is how easy it is to use, even for workers who are not computer-literate. A good way to demonstrate this is to describe the creation of an engineered method and standard with PIERS.

Standard data begins as a single item. It is meant to be added to like a pyramid, in a hierarchy that starts with the simple and expands into the complex. Each step in the pyramid is completely traceable. Beginning with an analysis of a simple item and adding analyses of the more complex items that follow, each item can be traced forward and backward. The standard can be broken backward all the way down to finger motions if necessary.

A technician developing a standard on the computer terminal enters the work area or sub-directory. The technician calls up the Lotus 1-2-3 program used for data entry and begins to fill out the "template." The template will contain all the "boilerplate" information he would normally re-enter on each work sheet. (Shipyards use a separate work sheet for each standard element.) The template contains the analyst's name, the document number, the item or standard title, and the word search criteria that would appear on each worksheet. As the analyst moves along creating each new worksheet, keystrokes and time are saved by not reentering the same information over and over. With each work sheet the analyst fills out, there is ample space for the standard element description, a reference description

that supplies the backup information to support the work being done, and the manhours to complete the standard element.

This information comes from an area known as REFTAB or "reference table." This reference table contains the standard data developed by the shipyards and in easily accessed by one of the following methods. Code number: the analyst is given the opportunity to insert the code number if it's known. Key word: by giving a keyword like "inspect," the section of the table containing "inspect" items will appear on the screen. Section: each section has an alphabetic designator assigned; if the alpha is entered, that section of the table will appear.

Once the code number is selected, the code appears on the screen with a "stock" description. This description can be edited to better suit the item. The user requests frequency of occurrence for that actions and the manhour allowance is automatically provided directly off the reference table. The program recomputes total manhours each time another reference description is entered. When the analyst has completed the entry of all references for that particular element, an Allowance Factor that applies to that specific element is entered and, once again, the program computes the newly adjusted time. After all entry work for a standard is complete, the analyst can produce a manhour allowance table or readable product that can be reviewed and edited. As soon as the standard is ready for final correction, the analyst can go back into the worksheets and make necessary corrections. Once again, the manhour allowance table is run and the document is ready for signature. The document can now be entered into the mainframe for distribution to all shipyards.

The procedure just described produces a finished and signed standard. It may create more standard data,which will increase the reference tables. It will also automatically update the shipyard index, so other shipyards can use the information.

SOFTWARE AND HARDWARE

It's clear that using PIERS to build a standard significantly improves efficiency *by* allowing the user to automate time-consuming manual steps. The two keys to using PIERS are its database and its software. The example given above shows how just a few software applications can make a major product difference. But PIERS has more than Just a few software and hardware tools. In addition to CATS E-X-P and the optical character reader, which have already been discussed, PIERS currently has:

word processing

spreadsheet analysis

statistical analysis

structural analysis

computer-aided design

drafting and chart graphics

projects scheduling

electronic mail (9)

as well as several other software applications that are not self-explanatory.

One, Costimator (10), is a computer-generated method of estimating manufacturing costs and times. The user can change the data base as needed by simply inserting new information. Based on general information the user supplies, the program calculates speeds, feeds, volumetric material requirements, and basic machining information. Additions and revisions can easily be made to the data base.

Another software package is the Engineering Document Library (EDL). This is a computerized "card catalog" that helps users by automating their searches for drawings, documents and backup data in a local data base.

A similar "card catalog," Special Machine Tools (SMT), allow users to search for machine tools developed at other shipyards (11).

The Engineering Drawing/Document Information Exchange System (EDDIE) makes possible the electronic transfer of documents, drawings and spreadsheet files between computer systems or shipyards.

SUMMARY

The PIERS system, with its hardware and software, now stores a large collection of standard time data and related documentation. Studies show that naval shipyards are averaging at least a 50 percent reduction in the time needed to create a standard. This percentage will increase as the size of the data base increases.

The system is developing continuously as new hardware features and new software technologies become available. An artificial intelligence project now underway is expected to make the different components of PIERS even

more integrated, automatic and user-friendly.

PIERS provides the naval shipyards with several significant benefits:

- Systematic description of each work process
- Organization of work measurement data into a structured, readily accessible medium
- Analysis of the production process to implement methods improvements
- Reduction in manual effort required to develop and maintain mandated time standard coverage levels
- Significant cost savings due to more efficient use of production resources (labor, materials, plant equipment); improved production processes; and higher quality control.

The biggest potential Pitfalls that would face a system similar to PIERS are not with the system itself or its users but with management support for the system. The Navy is supporting PIERS in the naval shipyards. Any organization that contemplates installing a similar system must place a high priority on standards development and maintenance and on management support to succeed.

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